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New XRF Developments Enhancing ENIG and ENEPIG Measurement Throughput and Precision

Zach Dismukes
Global Product Manager
Bowman Analytics, Inc

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What is XRF?

- XRF is a spectroscopic analytical method for measuring elemental composition and plating thickness
- Sensitive to all metallic elements (Al - U)
- Can measure thickness from sub-nanometer up to microns of thickness
- Performs thickness & composition simultaneously, up to 5 layers and 25 elements

Image is from Pinterest.com

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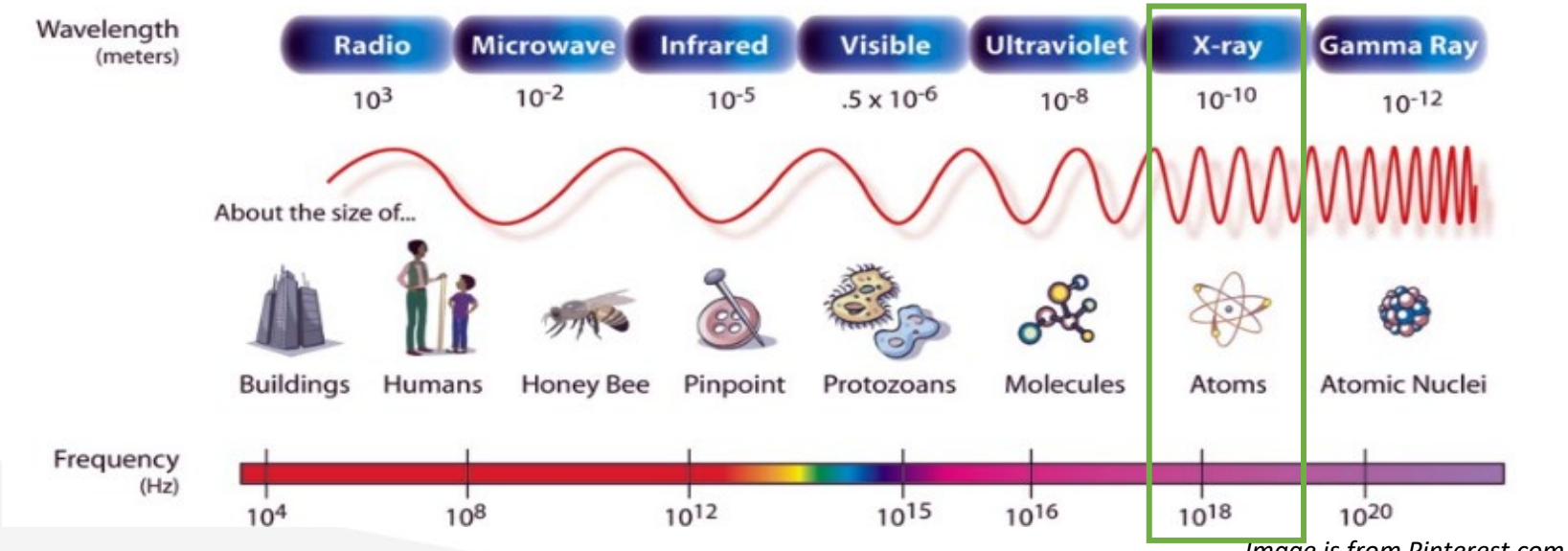
What are X-rays

- A type of radiation that is part of the electromagnetic spectrum
- X-Rays have a wavelength ranging from 0.03 to 3 nanometers



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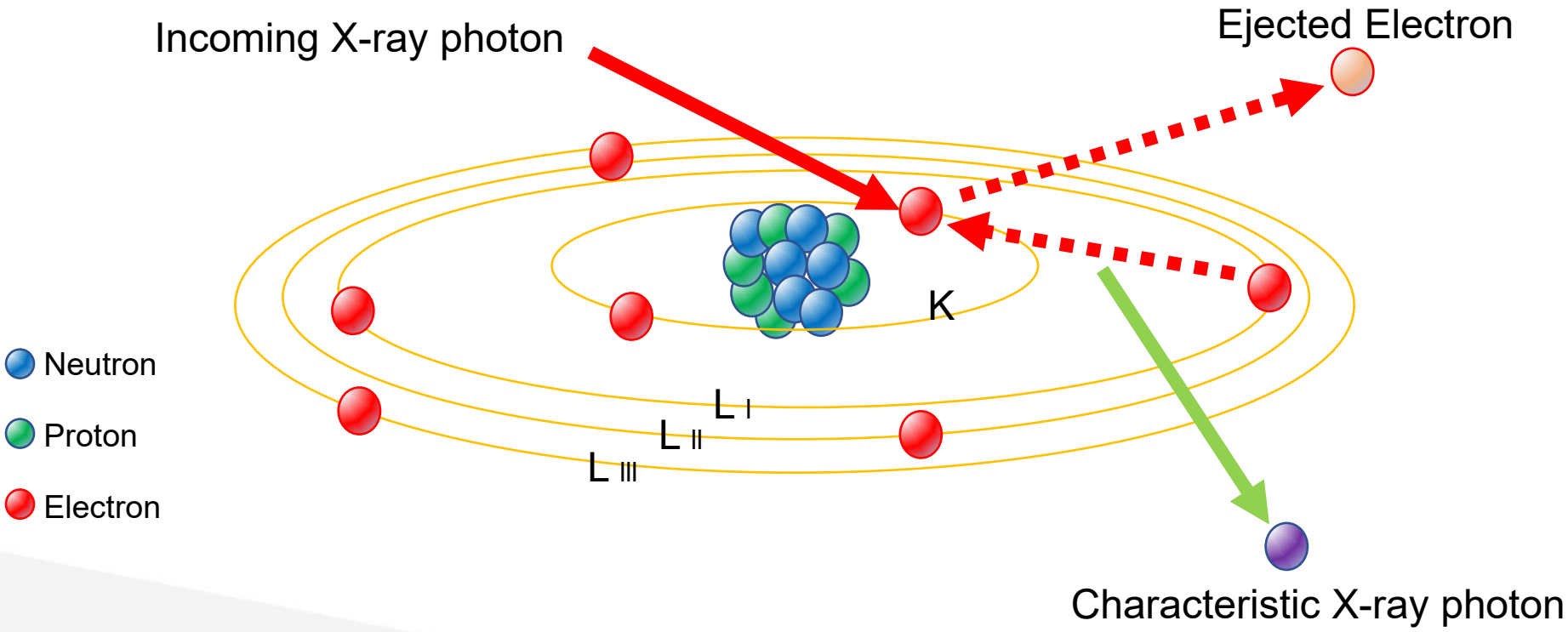
Characteristic Fluorescent Radiation



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IPC - 4552A Instrument Requirements

- Specifies the use of XRF to verify process and gage capability

$$C_g = \frac{0.2 \times T}{6 \times s}$$

$$C_{gk} = \frac{0.1 \times T - \{\text{difference of labeled value \& mean}\}}{3 \times s}$$

Requirement: $C_g \geq 1.33$ $C_{gk} \geq 1.33$

- New XRF developments enable requirements to be met with shorter measurement time

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New XRF Developments

- Large Window Silicon Drift Detectors (SDD)
- Polycapillary Optics for focusing x-ray beam
- Choice of Tube Target
- Software Automation
  - Autofocus
  - Pattern Recognition
  - Data Export

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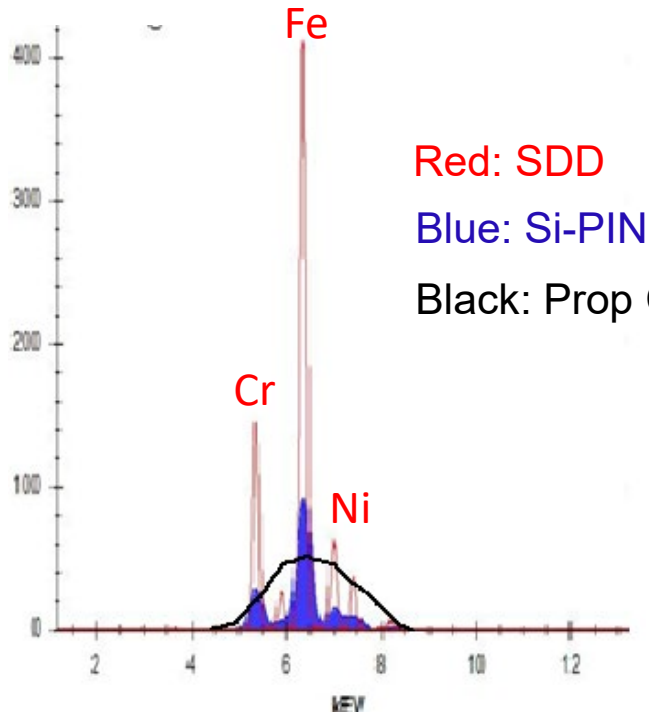
Advantage of Solid-State Detector



Red: SDD

Blue: Si-PIN

Black: Prop Counter

304 Stainless Steel Spectra from different detectors

- Improved signal sensitivity for low Z elements
- Improved detection limits down to nanometer or ppm level
- Better separation of overlapping elements
- Improved stability with minimal drift
- 10+ years life

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Large Window Solid State Detector

Table 1. Measuring 2.06µin Au, 121µin Ni-P (8%P) standard.

	SiPin 24mil Collimator		Large-SDD 24mil Collimator	
Element	Au	Ni-P	Au	Ni-P
Average (µin)	2.08	120	2.06	121
Std Dev	0.023	0.458	0.014	0.268
C_g	3.44	8.60	5.67	14.7
C_{gk}	3.10	8.00	5.56	14.4

- SDD offers highest count rates and resolution
  - >50% higher than SiPin
- Lowest baseline noise
- Light element capability (i.e. P, Si, Al)
- Best for finishes <1 µm, complex films such as ENIG, EPIG, ENEPIG

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Polycapillary Optics

- Sub-million to multi-million capillary channels
- X-ray passing through each channel is aligned to a high intensity point
- Perfect for very small features, down to 7.5µm spot size
- High flux density gain – 100x higher than a pinhole collimator
- Improve precision of readings with shorter time.

Table 2. Measuring 2.06µin Au, 121µin Ni-P (8%P) standard.

	80µm Optics,		15µm Optics	
Element	Au	Ni-P	Au	Ni-P
Average (µin)	2.06	121	2.05	121
Std Dev	0.015	0.155	0.010	0.107
C_g	5.27	25.5	7.51	36.7
C_{gk}	5.17	24.8	7.28	35.9

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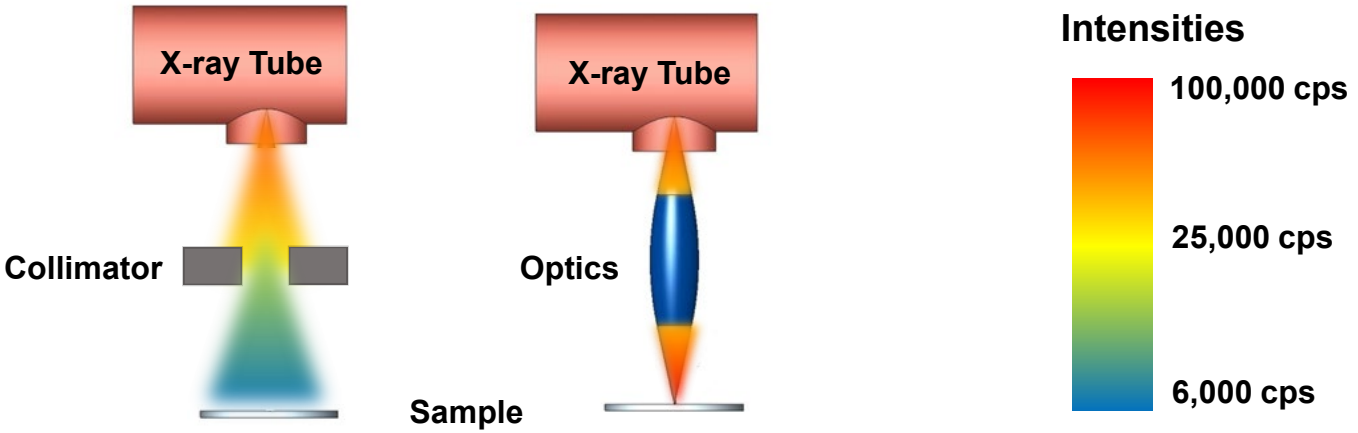
Polycapillary optics reduce the inverse square loss

- Intensity is inversely proportional to the square of the distance from the source of that physical quantity.
- 100x higher flux than collimated system at the same distance from the source.



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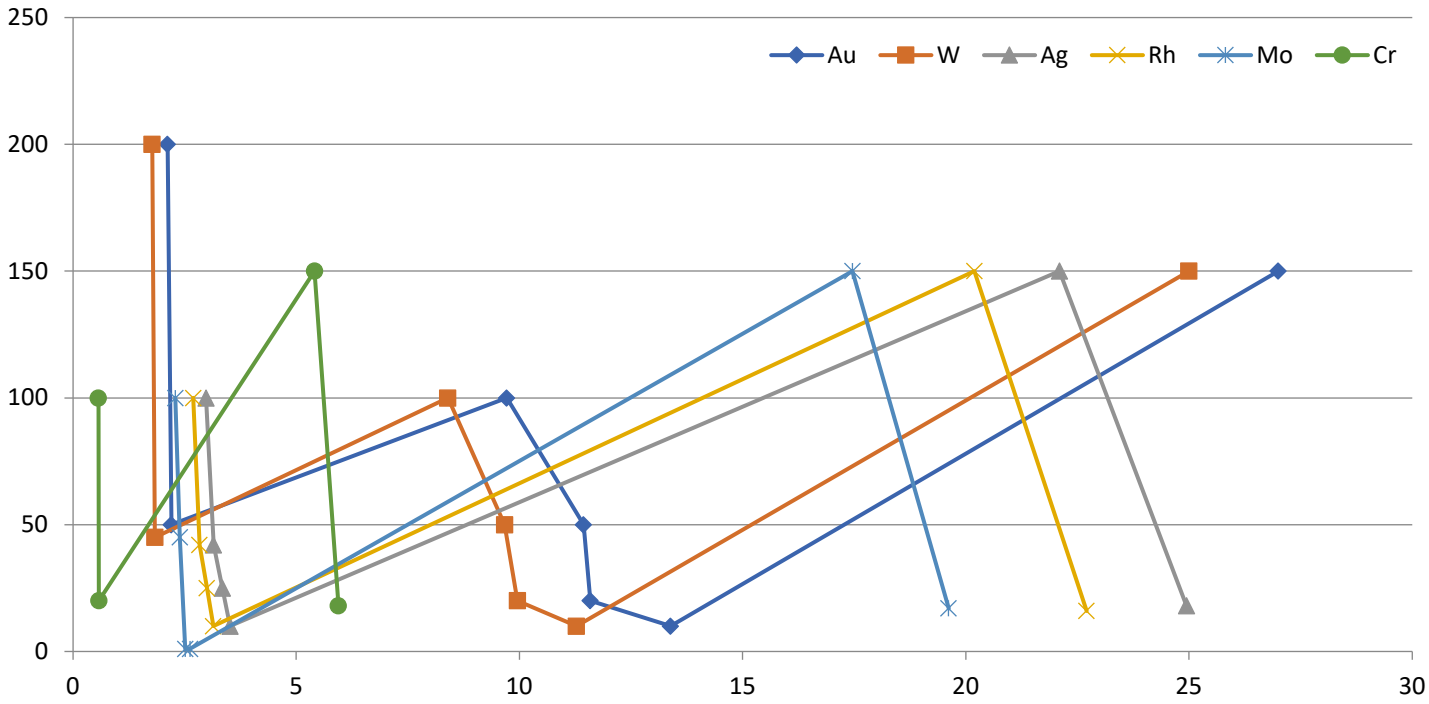
Potential of Different Tube Target



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Auto Focus (Laser)

- Quickly and automatically focus on samples
- Ensures each sample is measured at the same working distance
- Minimizes error from different operators

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Pattern Recognition

- Corrects position when the measurement location is off
- Automatically find next measurement location
- Minimize operator error
- Speed of process – Throughput

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XYZ Programming

- Read parts in random, linear, or grid patterns. Just pick a start & end point.
- Datum reference points can compensate for up to ±10° sample rotation
- Allows for fast measurement of multiple pad locations

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Automatic Data Export

- Automatically export data to XRF PC
  - Export at end of each test
  - Export data linked with unique identifiers (i.e barcode, part number)
- Fully customizable data export
  - Export raw data
  - Automatically generate reports

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Q & A

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